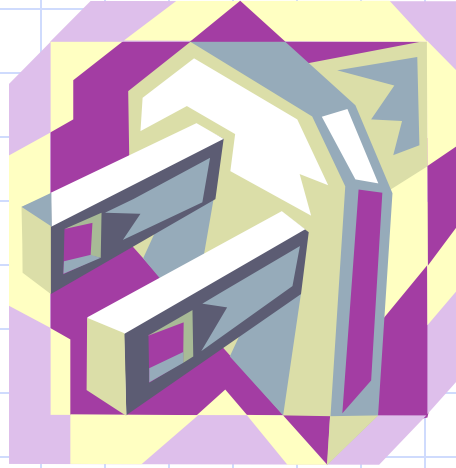


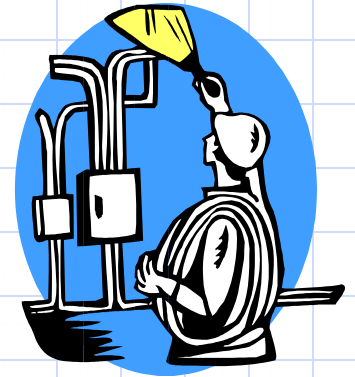
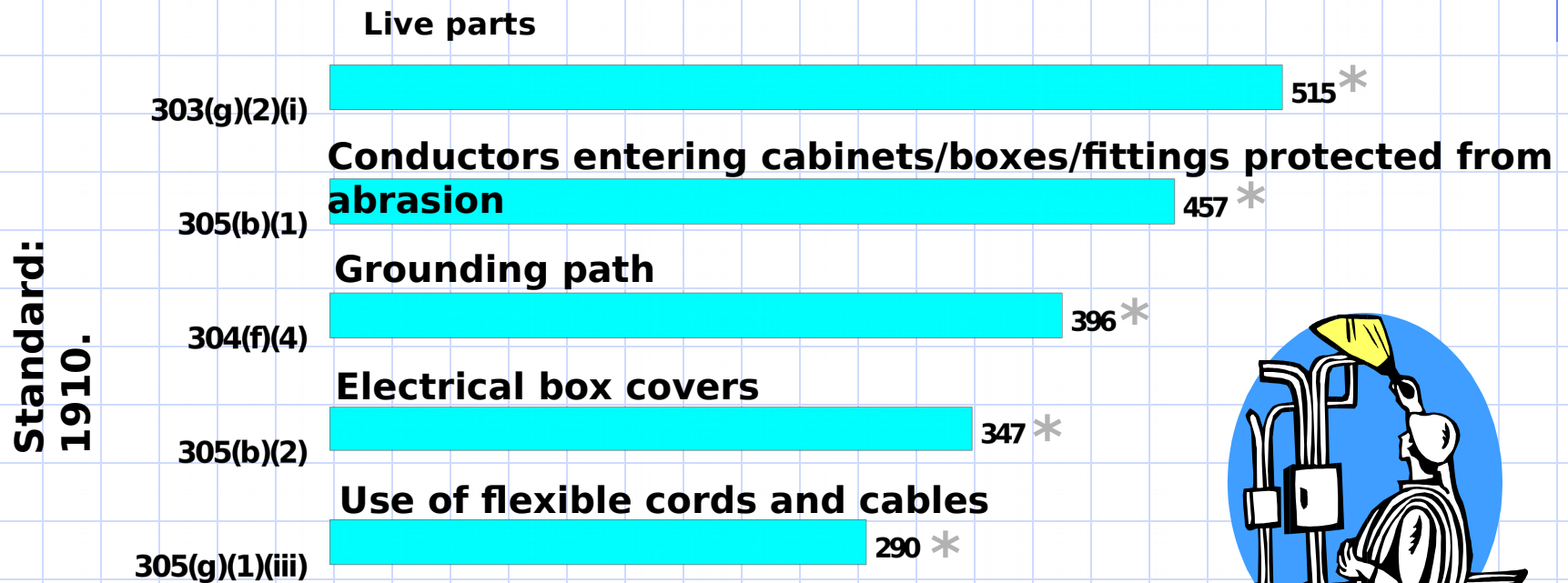
# Electrical



# Safety

# Subpart S 1910.301-399

# Subpart S - Electrical (1910.301 - 399)



\*Average number of Federal OSHA citations issued  
between 2000 and 2003

# DEFINITION

- ◆ A physical agency caused by the motion of electrons, protons, and other charged particles, manifesting itself as an attraction, repulsion, magnetic, luminous, and heating effects, etc.

# ELEMENTS & ATOMS

- ◆ Every known substance – solid, liquid or gas is composed of elements
- ◆ An atom is the smallest particle of an element that retains all the properties of that element
- ◆ Each element has its own kind of atom

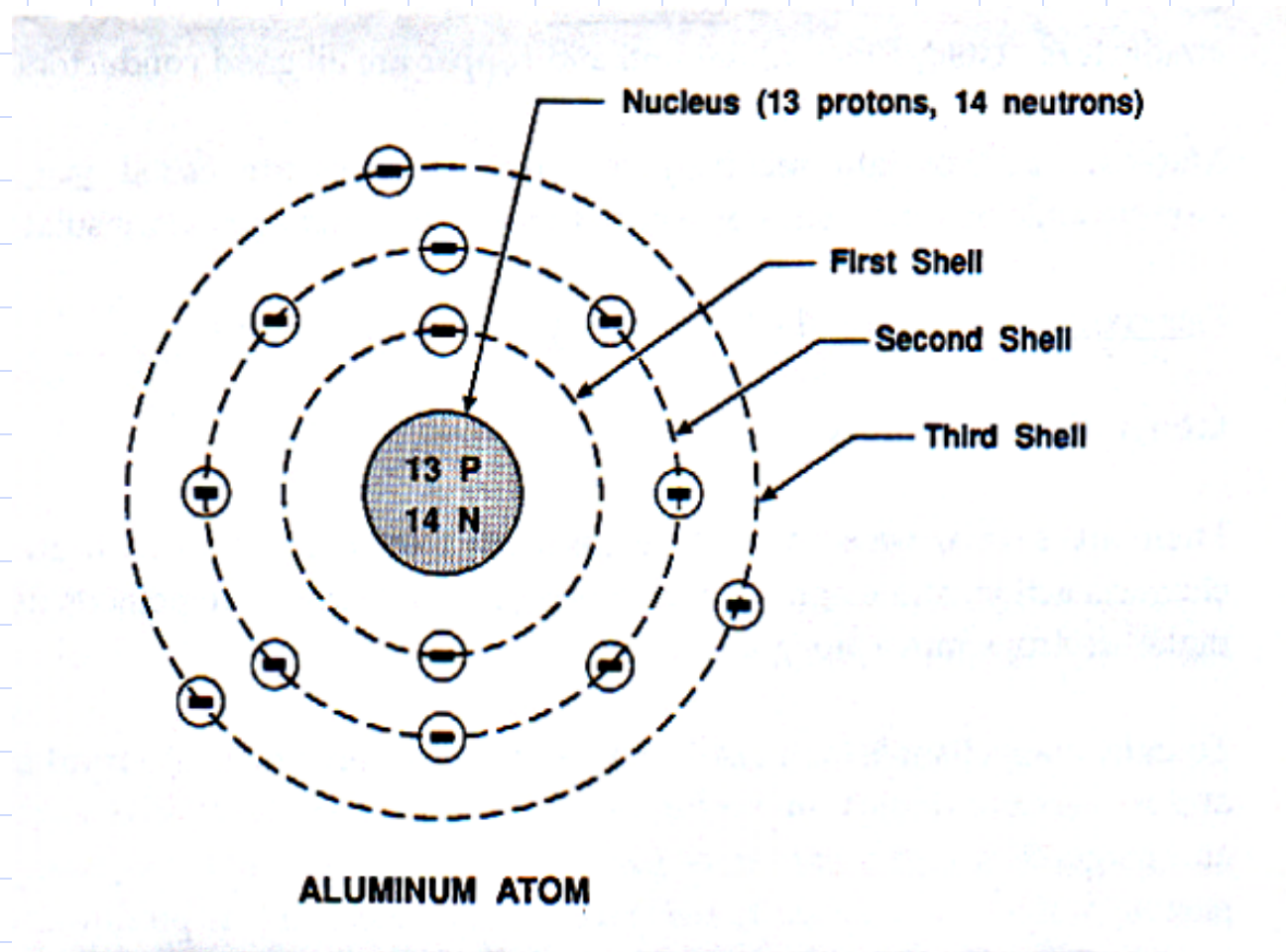
# ATOMS

- ◆ Inner part composed of protons & neutrons
- ◆ Outer part composed of electrons
- ◆ Protons = positive charge
- ◆ Neutrons = no charge
- ◆ Electrons = negative charge

# ATOMS

- ◆ Each element has a definite number of electrons ----and the same number of protons
- ◆ They are oppositely charged and therefore attract each other. This tends to hold the electrons in orbit around the atom.

# ELECTRICALLY BALANCED ATOM



# FREE ELECTRONS

- ◆ Some atoms are easily moved out of orbit
- ◆ The ability to move or flow is the basis of current electricity
- ◆ If channeled in a given direction, a flow of electrons occurs --- when flowed through a conductor it is **dynamic electricity**

# ELECTICAL MATERIALS

- ◆ CONDUCTOR – contains many free electrons --- gold, copper, silver, aluminum
- ◆ INSULATOR – contains few free electrons-Usually non-metallic such as wood, rubber, glass, etc

# GENERATING ELECTRICITY

- ◆ Friction, pressure, heat, light, chemical reaction, and magnetism
- ◆ Magnetism is most practical & inexpensive method
- ◆ Electricity is produced when a magnet is moved past a piece of wire, or wire is moved through a magnetic field

# VOLTAGE, CURRENT, & RESISTANCE

- ◆ VOLTAGE – unit of measurement of electromotive force (EMF)
- ◆ CURRENT – Continuous movement of electrons past a given point. (measured in amperes)
- ◆ RESISTANCE – Opposition to movement of electrons. Makes it possible to generate heat, control current flow, & supply correct voltage to devices

# OHM'S LAW

## ◆ George Simon Ohm

- Formulated a mathematical relationship between:
  - ◆ Current
  - ◆ Voltage
  - ◆ Resistance
- Resistance = Impedance
  - ◆ Resistance = DC
  - ◆ Impedance = AC
  - ◆ Interchangeable – Most Branch circuits

# DIRECT CURRENT

- ◆ Always flows in one direction
- ◆ Used to charge batteries, run some motors, operate magnetic lifting devices and welding equipment.

# ALTERNATING CURRENT

- ◆ More common in electrical work
- ◆ Changes rapidly in both direction and value
- ◆ Power companies produce power cheaper with alternating current

# ELECTRICAL HAZARDS

- ◆ **SHOCK.** Electric shock occurs when the human body becomes part of the path through which current flows.
- ◆ The direct result can be electrocution.
- ◆ The indirect result can be injury resulting from a fall or movement into machinery because of a shock

# ELECTRICAL HAZARDS

- ◆ **BURNS.** Burns can result when a person touches electrical wiring or equipment that is energized.
- ◆ **ARC-BLAST.** Arc-blasts occur from high- amperage currents arcing through the air. This can be caused by accidental contact with energized components or equipment failure.

# Arc Flash and Arc Blasts

## ◆ Arc Flash:

- 80%-Burns due to ignition of clothing
- Temperature-35,000 F
- Fatal Burns-10 ft.
- 2000 people hospitalized with burns
- Molten metal

## ◆ Arc Blast:

- Pressure Wave
- Heat
- Molten metal
- Destruction of structures and life

# Arc Blast

## ◆ Cause

- Short Circuit caused by working on energized equipment
  - ◆ Dropped Tool
- Occurs in milliseconds
- Temp: 30,000 degrees
- Air expands very violently
  - ◆ 15 tons of pressure

# ELECTRICAL HAZARDS

- ◆ **ARC-BLAST. The three primary hazards associated with an arc-blast are:**
  - ◆ **Thermal radiation.**
  - ◆ **Pressure Wave.**
  - ◆ **Projectiles.**

# ELECTRICAL HAZARDS

◆ **EXPLOSIONS.** Explosions occur when electricity provides a source of ignition for an explosive mixture in the atmosphere.

# ELECTRICAL HAZARDS

- ◆ **FIRES.** Electricity is one of the most common causes of fires both in the home and in the workplace. Defective or misused electrical equipment is a major cause.

# EFFECTS ON THE HUMAN BODY

**Depends on:**

- ◆ **Current and Voltage**
- ◆ **Resistance**
- ◆ **Path through body**
- ◆ **Duration of shock**

# Effects of AC Electricity

- ◆ More than 3 mA- Painful shock-  
cause indirect accident
- ◆ More than 10 mA- Muscle  
contraction – “No Let Go” danger
- ◆ More than 30 mA- Lung paralysis,  
usually temporary

# Effects of AC Electricity

- ◆ More than 50 mA- Ventricular fibrillation, usually fatal
- ◆ 100 mA to 4 A- Certain ventricular fibrillation, fatal
- ◆ Over 4 A- Heart paralysis, severe burns

# Effects

## ◆ Protection

- Circuit Breakers
- Fuses
- 15 or 20 amps
- Property/equipment protection

# Conductors

## ◆ American Wire Gauge

- 12 gauge – 20 amps (Safely)
- 14 gauge – 15 amps
- 10 gauge – 30 amps

## ◆ What determines amount of amps through a circuit?

- How much the equipment draws
- How much “stuff” plugged in

# Protective Devices

- ◆ Fuses

- ◆ Circuit Breakers

- Trip or break circuit breakers if conductors exceed their ampacity

# Summary

- ◆ Current ( $I$ )
- ◆ Voltage ( $E$  or  $v$ )
- ◆ Resistance ( $R$ ) (Ohms)

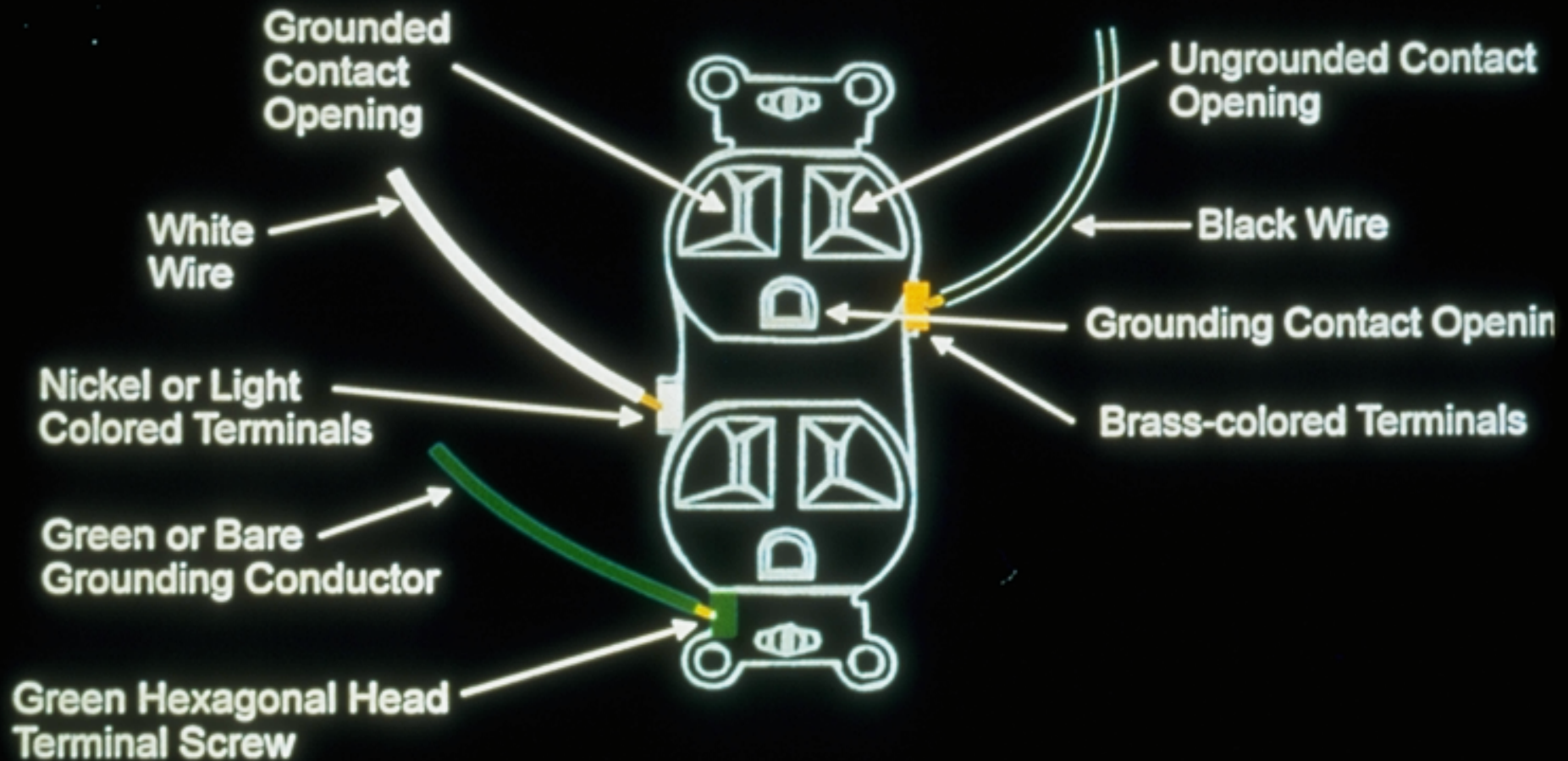
# Electrocution Triangle

- ◆ Electricity (levels)
- ◆ Time
- ◆ Path

# Wires

- ◆ Black = hot = Ungrounded Conductor
- ◆ White = neutral = Grounded Conductor (connected to grounding electrode/Grounding rod)

# Duplex Receptacle Correctly Wired to Designated Terminals



# How to check

## ◆ Wiring Checks

- Testers
- Different types

# Instruments

## ◆ Normal 3 light Tester

- Won't check resistance to ground

## ◆ Others - Check what the 3 light tester will

- Also checks resistance for ground

# Double Insulated

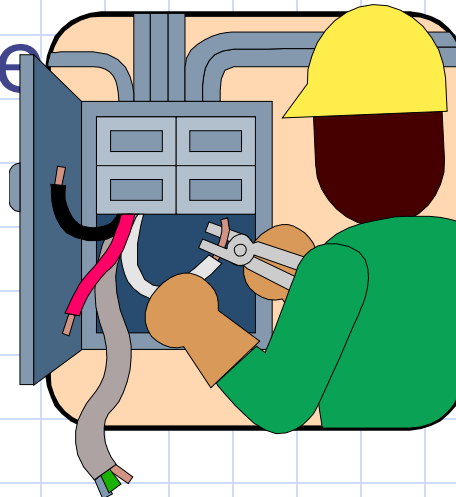
## ◆ Indicators

- No ground pin
- Plastic tool case
- Listed by NTL
- Marked as double insulated
  - ◆ Square in a square
  - ◆ Marked “double insulated”

# 1910.302 Electrical Utilization Systems

## ◆ Scope:

- (a) Covers electrical installations and utilization equipment installed or used within or on buildings, structures, and other premises



# 1910.303 General Requirements

(a) Approval. The conductors and equipment required or permitted by this subpart shall be acceptable only if approved

- **1910.303(a) Approval**

- All electrical conductors and equipment shall be approved.

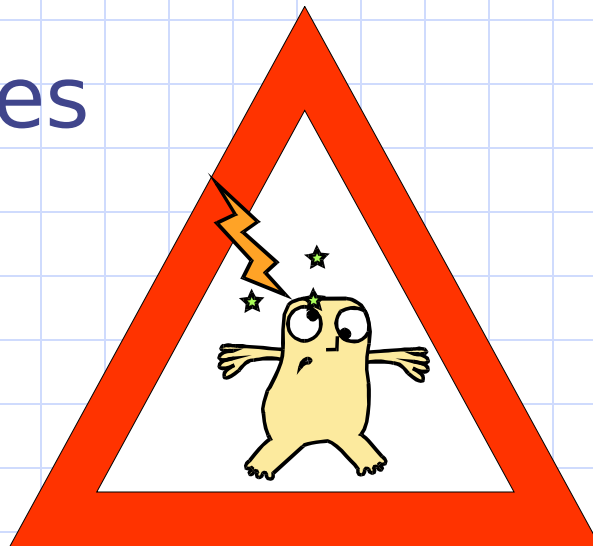


1910.303(a)  
NEC Article 110-2

# 1910.303 (b) Examination, installation and use

## ◆ Employer Obligation:

- (1) Electrical equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees



1910.303 (b)

## Examination,

## installation, and use

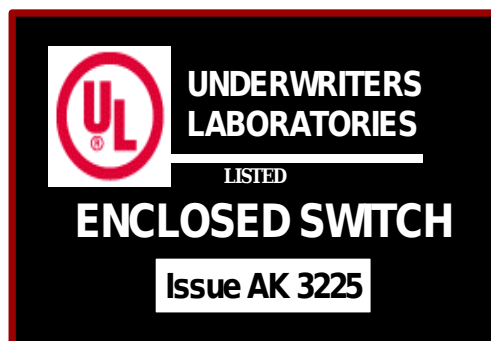
◆ (1) Examination. Safety of equipment shall determined using the following considerations:

- (i) **Suitability of equipment** for an identified purpose may be evidenced by listing or labeling for that identified purpose.



- **1910.303(a) Approval**

- All electrical conductors and equipn shall be approved.



1910.303(a)  
NEC Article 110-2

## **NRTL'S (Nationally Recognized Testing Laboratories)**

Applied Research  
Laboratories, Inc.  
(ARL)



Detroit Testing  
Laboratory, Inc.  
(DTL)



Intertek Testing Services  
NA, Inc. (ITSNA)  
(formerly ETL Testing  
Laboratories, Inc.)



Southwest Research  
Institute (SWRI)



Canadian Standards  
Association (CSA)  
(also uses initials "US" instead  
of "NRTL" in its markings)



Electro-Test,  
Inc. (ETI)



MET Laboratories,  
Inc. (MET)



TUV Rheinland  
of North America,  
Inc. (TUV)



Canadian Standards  
Association (CSA)  
(time limited use of mark  
formerly used by the  
American Gas Association  
(AGA))



Factory Mutual Research  
Corporation (FMRC)



Wyle Laboratories  
(WL)



Communication  
Certification  
Laboratory,  
Inc. (CCL)



Intertek Testing Services NA,  
Inc. (ITSNA) (formerly ETL  
Testing Laboratories, Inc.)



Underwriters Laboratories  
Inc. (UL)



SGS U. S. Testing Company,  
Inc. (SGSUS) (formerly U.S.  
Testing Company, Inc.)

# Identification of Disconnecting Means and Circuits

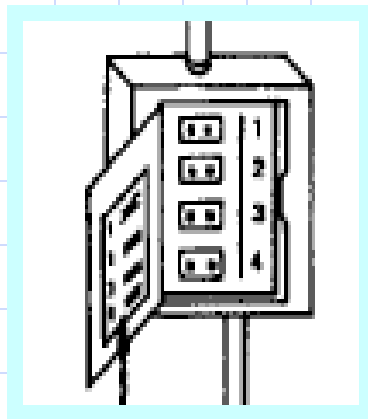
- ◆ Each disconnecting means legibly marked to indicate its purpose
  - (Unless so arranged so the purpose is evident)



Disconnect switch for  
motor number 3

# 1910.303 (f) ID of Disconnecting Means

- ◆ Each service, feeder, and branch circuit, at its overcurrent device, legibly and durably marked to indicate its purpose
- ◆ Switches and circuit breakers must be clearly labeled to indicate its circuit's function



**Circuit breaker for motors  
1,2,3, and 4**

# 1910.303(g) Working Space

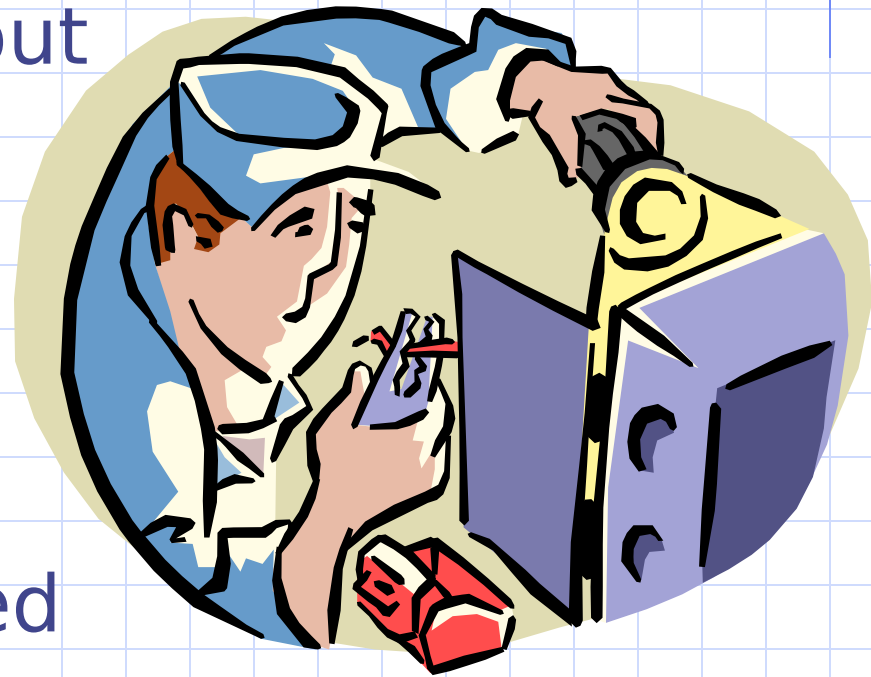
- ◆ (1) Sufficient access and working space around all electrical equipment, provided & maintained to provide ready and safe operation and maintenance
- ◆ (ii) Not used for storage
- ◆ (ii) If located in a room or area, working space shall be suitably guarded



# 1910.303(g)(1)(v)

## Illumination

- ◆ Illumination provided for all working spaces about service equipment, switchboards, panelboards, and motor control centers installed indoors.



# 1910.303(g)(1)(vi)

## Headroom

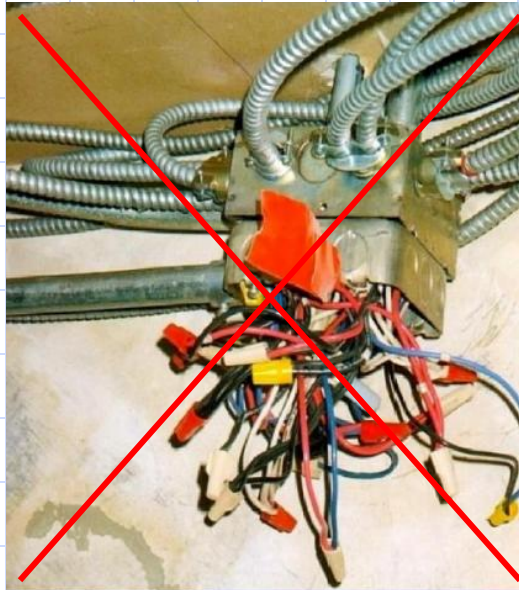


6'3"

- ◆ The minimum headroom of working spaces about service equipment, switchboards, panelboards, or motor control centers shall be 6 feet 3 inches

# 1910.303(g) Guarding of live parts

✓ (4)(1) Live parts of electric equipment operating at 50 volts or more guarded against accidental contact by approved cabinets



# Guarding live parts - 1910.303

◆ (g)(2)(i) or other forms of approved enclosures, or by any of the following means:

- (A) By location in a room, vault, accessible only to qualified persons
- (B) By permanent, substantial partitions or screens
- (C) By location on a suitable balcony or platform as to exclude unqualified persons
- (D) By elevation of 8 feet or more above working floor or other



# 1910. 303(g) Guarding live parts

- ◆ (2)(iii) Entrances to rooms and other guarded locations containing exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter



# 1910.303(h)(3)(ii) Illumination

- ◆ Adequate illumination for all working spaces about electric equipment
- ◆ The lighting outlets arranged that persons changing lamps or making repairs on the lighting system will not be endangered by live parts or other equipment

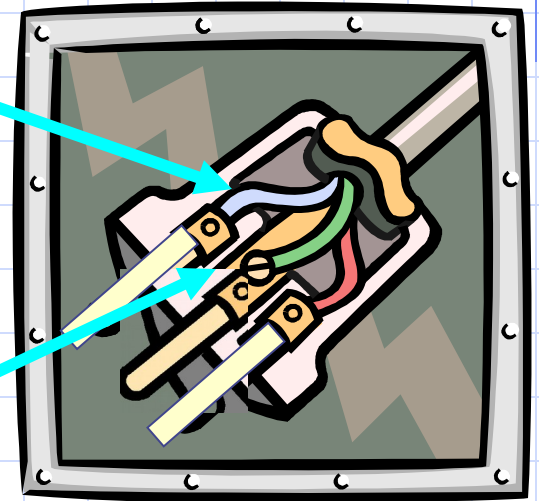


1910.304

# Wiring Design and Protection

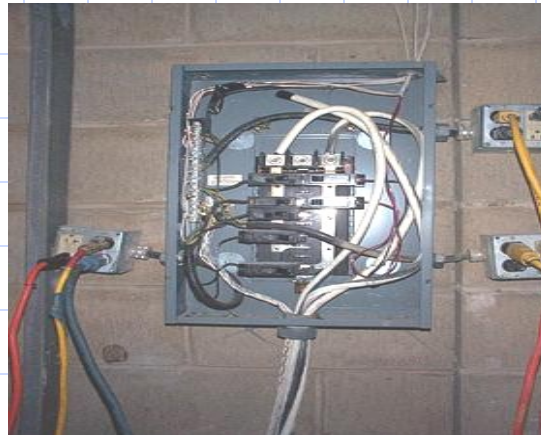
# 1910.304(a)(1) Identification of Conductors

- ◆ A conductor used as a grounded conductor shall be identifiable and distinguishable from all other conductors.
- ◆ A conductor used as an equipment grounding conductor shall be identifiable and distinguishable from all other conductors



# Identification of Conductors

- ◆ Grounded conductor and equipment grounding conductors marked or color coated
- ◆ So that employees can i.d. and tell apart
- ◆ **Grounded conductor is an energized circuit** (conductor that is connected to earth through the system ground) Commonly referred to as the *neutral*

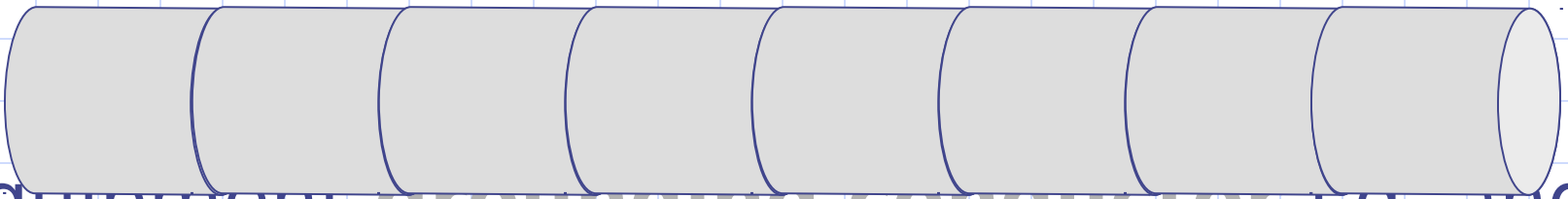


# Grounding Conductors

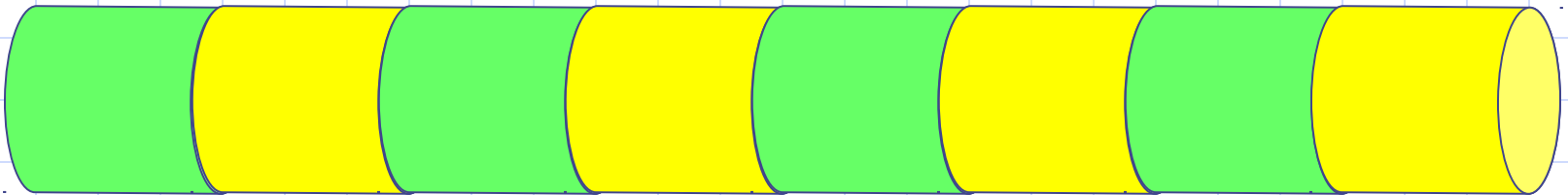
- ◆ **Equipment grounding conductor** acts as a safeguard against insulation failure or faults in the other circuit conductors
- ◆ **Not an energized conductor** under normal conditions.
- ◆ Energized if a leak or fault in the normal current path
- ◆ Directs current back to the source
- ◆ Enabling fuses or circuit breakers to operate

# Identification of Conductors

- ◆ **Grounded conductor** i.d. and distinguished from other conductors w/ white or gray

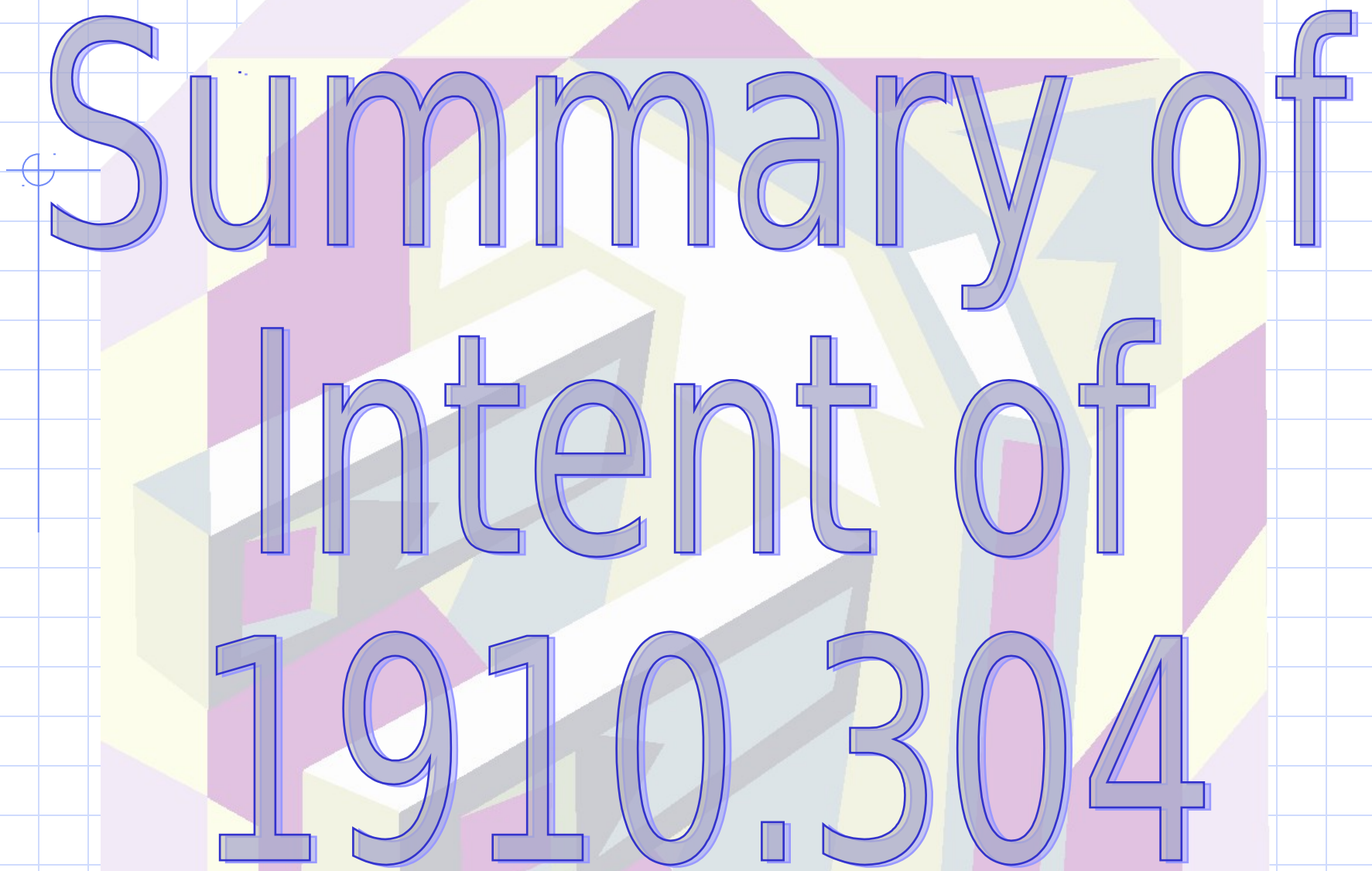


- ◆ **Equipment grounding conductor** i.d. and distinguished w/ **green**, green w/ yellow stripes, or bare



# 1910.304(a) Use and identification of grounded and grounding conductors

- ◆ (2) No grounded conductor may be attached to any terminal or lead so as to reverse polarity
- ◆ (3) A grounding terminal on a receptacle, cord connector, or plug may not be used for purposes other than grounding



# Summary of Intent of 1910.304

# Polarity of connections

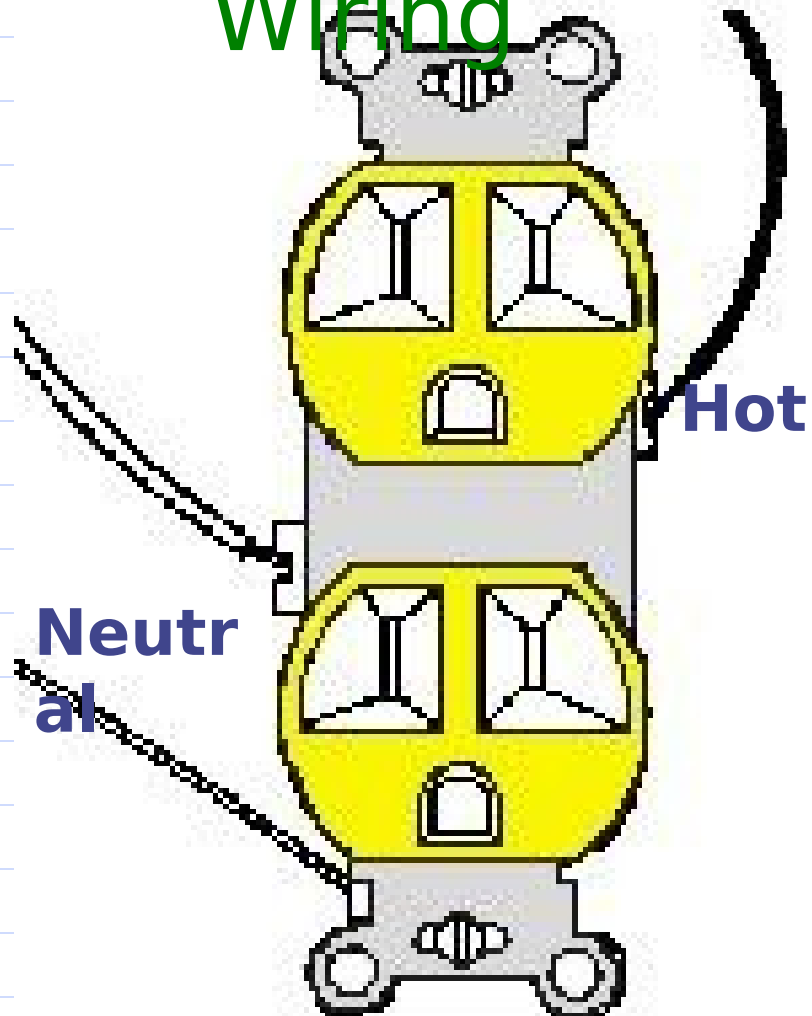
- ◆ Improper connection of these conductors (*'hot and neutral'*) is most prevalent on smaller branch circuits:
  - Standard 120 volt receptacle outlets
  - Cord-and plug-connected equipment



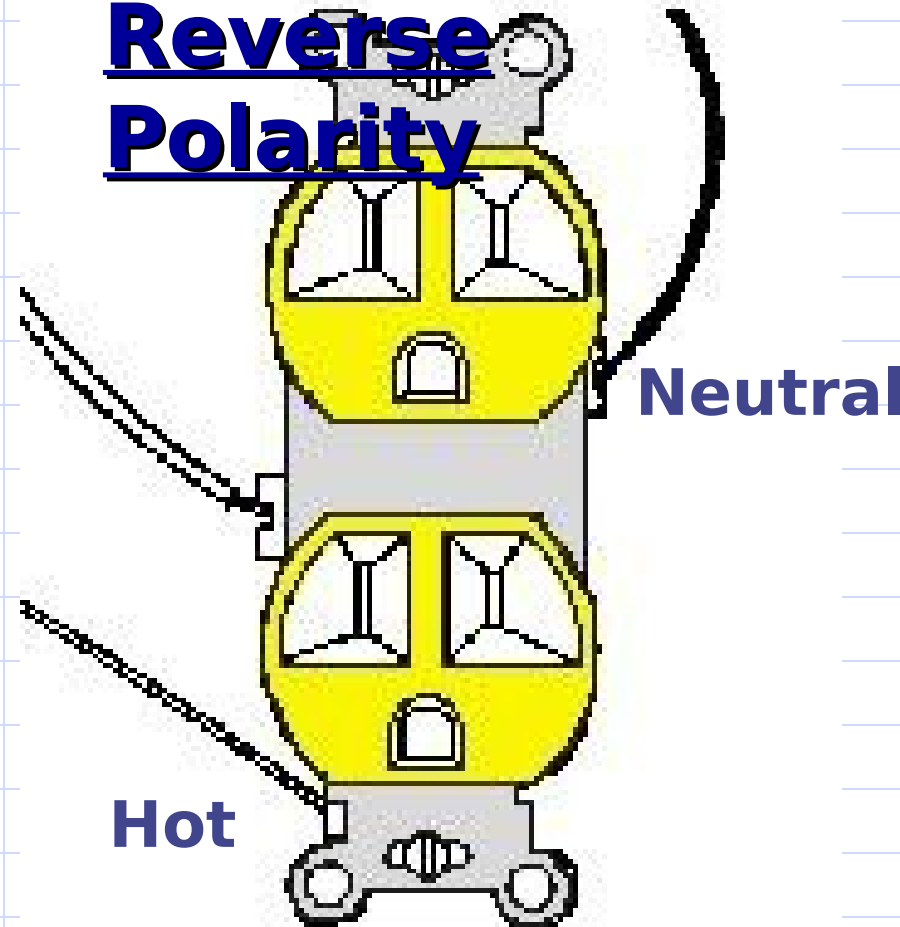
# Reversed Polarity

◆ *Reversed polarity* is a condition when the grounded conductor (neutral) is incorrectly connected to the ungrounded (hot) terminal of a plug, receptacle, or other type of conductor

## Normal Wiring



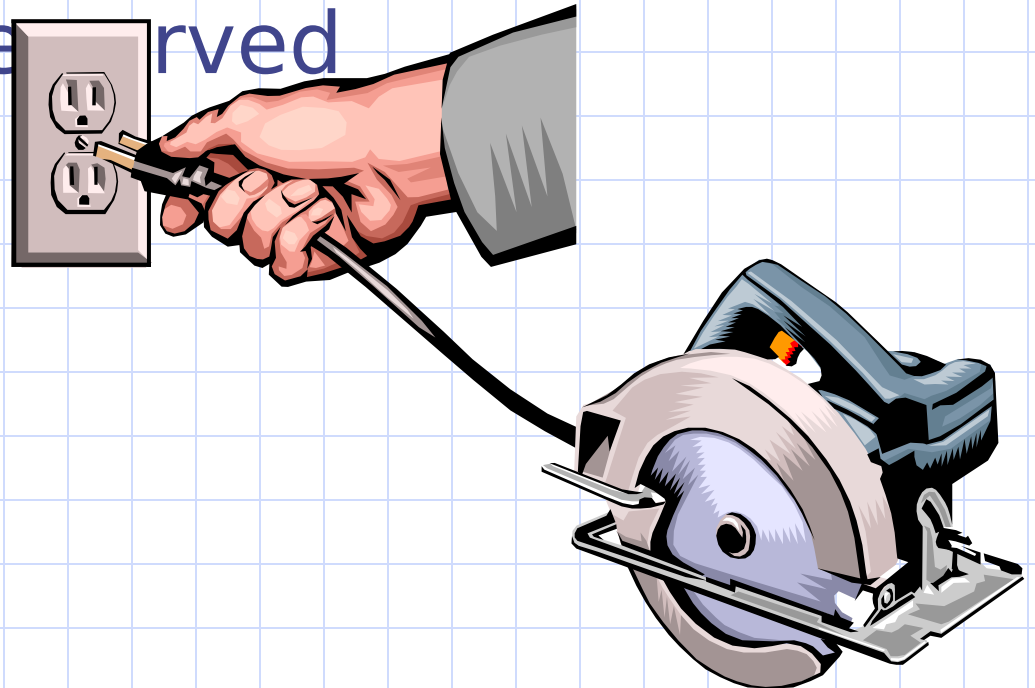
## 1910.304(a) (2) Reverse Polarity



1910.304(a)(2)  
NEC Article 200-11

# 1910. 304(b) Branch circuits

1. Reserved
2. Outlet devices. Outlet devices shall have an ampere rating not less than the load to be served



# 1910. 304 (d)(1) Disconnecting means

- ◆ General. Means shall be provided to disconnect all conductors in a building or other structure from the service-entrance conductors.
- ◆ The disconnecting means shall plainly indicate whether it is in the open or closed position and shall be installed at a readily accessible location nearest the point of entrance of the service-entrance conductors.



1910. 304 (d)(2)

## Services over 600 volts, nominal

- ❖ (i) Guarded to make them accessible only to qualified persons
- ❖ (ii) Signs warning of high voltage shall be posted where other than qualified employees might come in contact with live parts



# 1910. 304 (e)(1)(vi) Circuit breakers

- ❖ Circuit breakers shall clearly indicate whether they are in the open (off) or closed (on) position



# 1910. 304 (f) Grounding

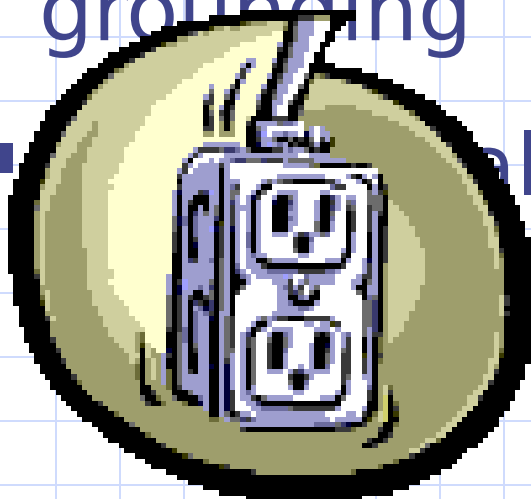


- ◆ (4) **The path to ground from circuits, equipment, and enclosures shall be permanent and continuous**

# Grounding

◆ There are two kinds of grounding:

- 1. Electrical circuit or system grounding



- 2. Equipment grounding



# Electrical System Grounding

- ◆ One conductor of the circuit is intentionally grounded to earth
- ◆ Protects circuit from lightning, or other high voltage contact



# Equipment Grounding

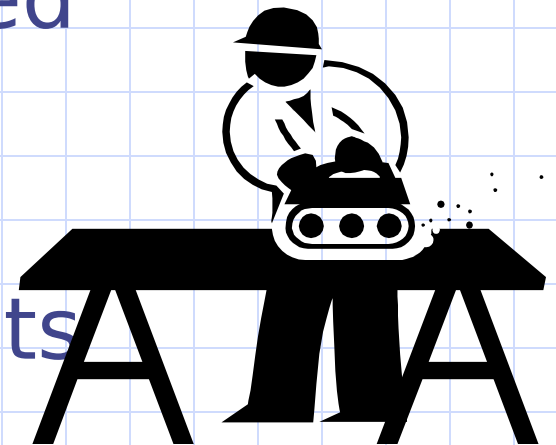
- ◆ All metal frames & enclosures of equipment are grounded by a permanent connection or bond



- ◆ The equipment grounding conductor provides a path for dangerous fault current to return to the system ground at the supply source should a fault occur

# Grounding Equipment Connected by Cord and Plug

- ◆ Exposed non-current carrying metal parts of cord and plug connected equipment which may become energized shall be grounded
- ◆ If in a hazardous location
- ◆ If operated at over 150 volts

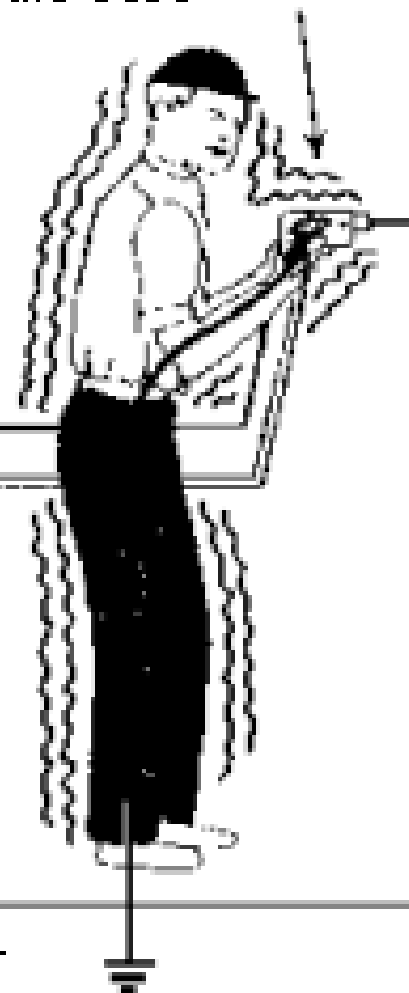
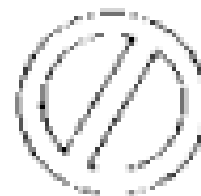


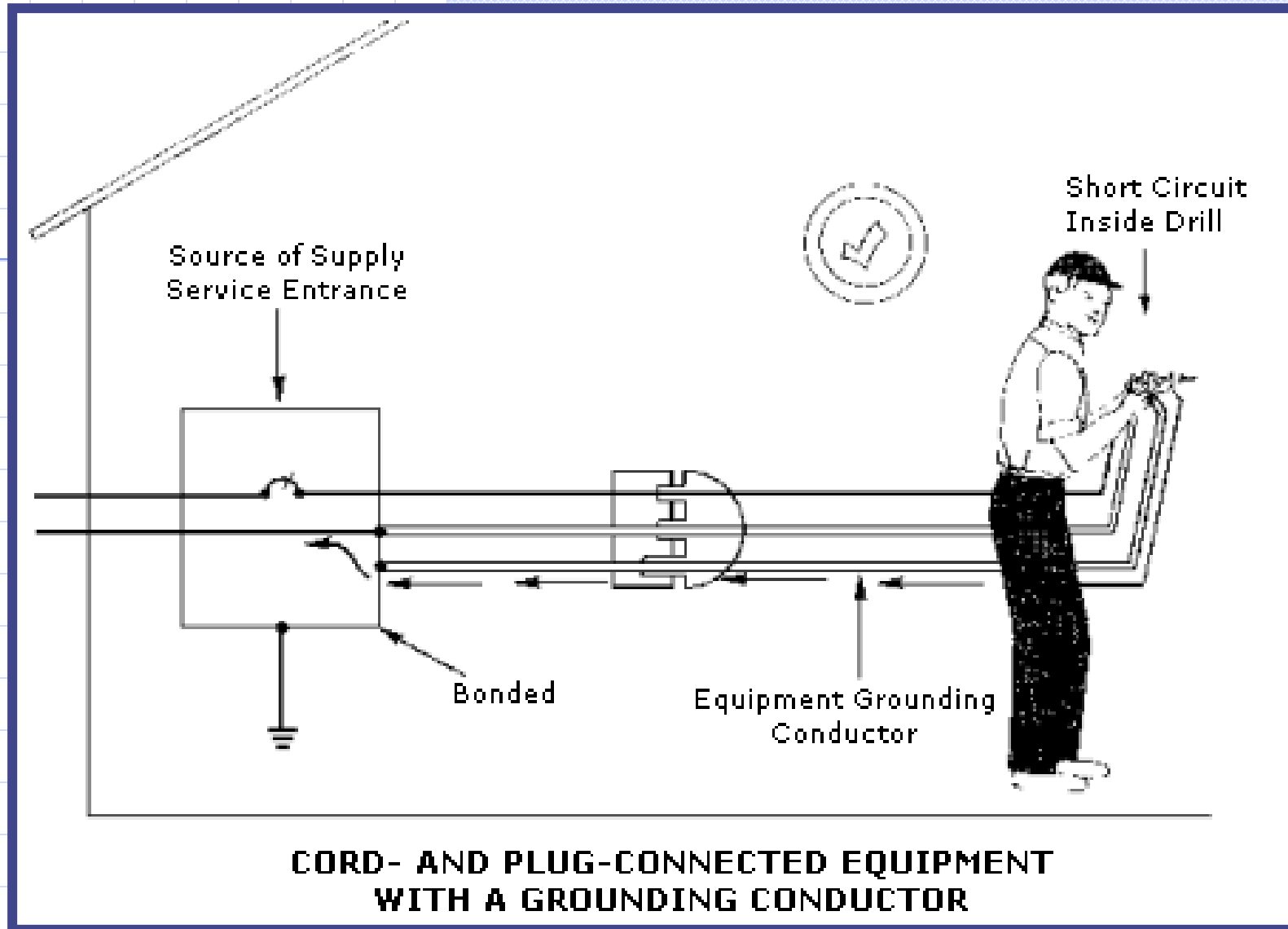
Source of Supply  
Service Entrance

A Short Circuit Inside  
the Drill Will Energize  
the Case

Bonded

**CORD- AND PLUG-CONNECTED EQUIPMENT  
WITHOUT A GROUNDING CONDUCTOR**





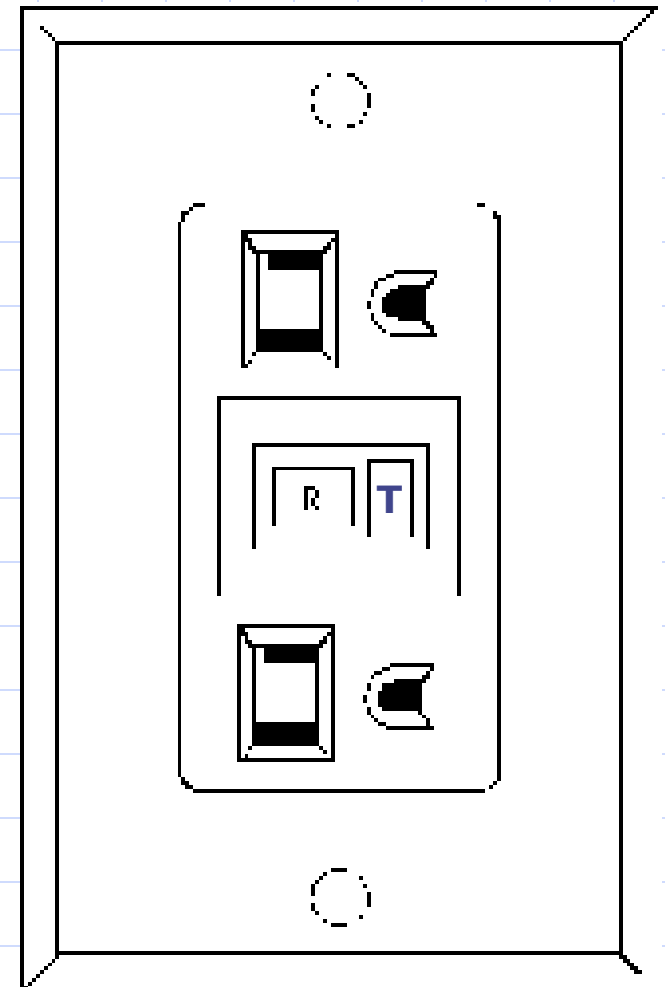
Note that properly bonded conduit and associated metal enclosures can also serve as a grounding conductor.

# Ground fault circuit interrupters (GFCI's)

- ◆ A GFCI is not an overcurrent device like a fuse or circuit breaker
- ◆ GFCI's are designed to sense an imbalance in current flow over the normal path

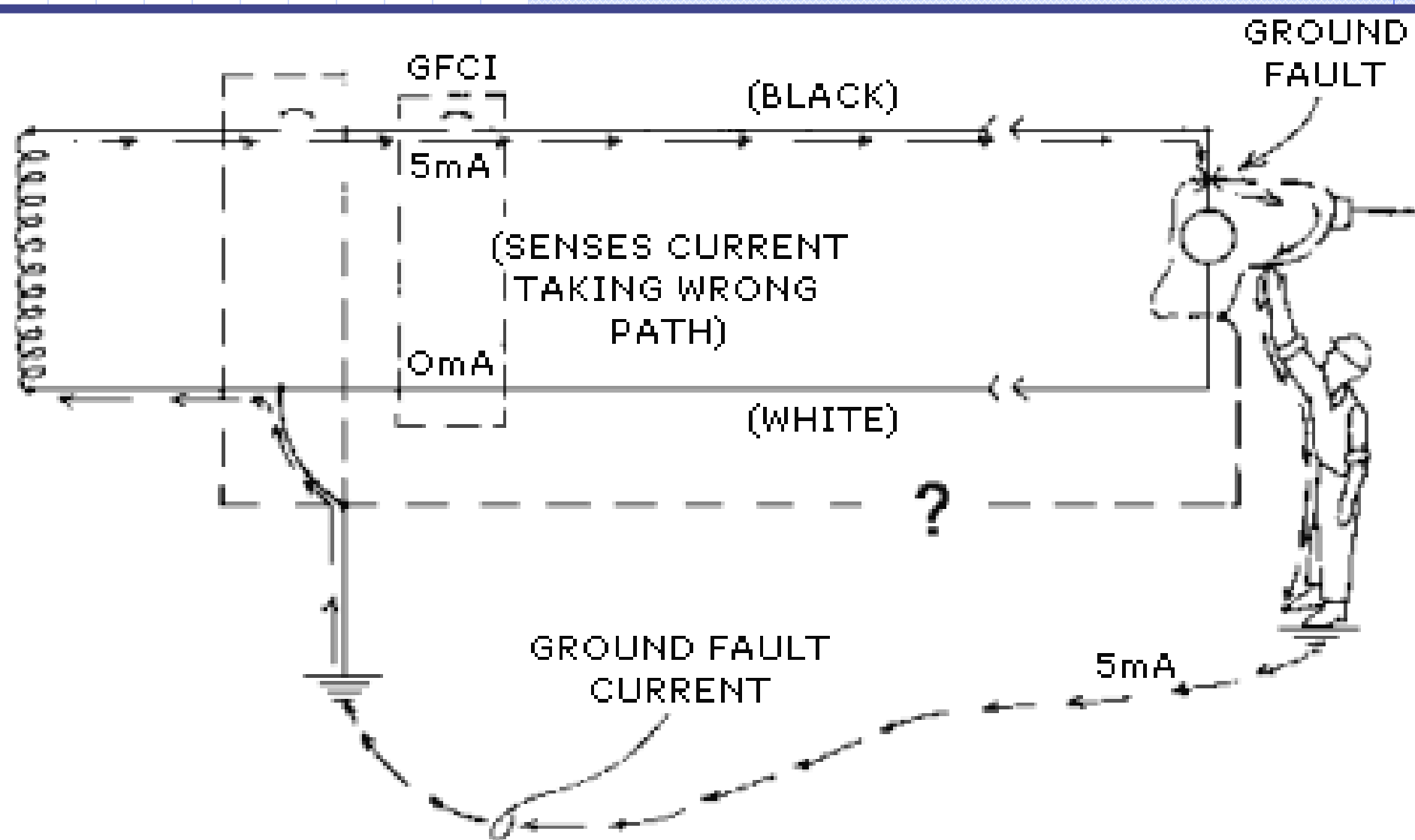
# Ground fault circuit interrupters (GFCI's)

- ◆ GFCI contains a special sensor that monitors the strength of the magnetic field around each wire in the circuit when current is flowing
- ◆ The field is proportional to the amount of current flow



# Ground fault circuit interrupters (GFCI's)

- ◆ If the current flowing in the *black (ungrounded)* wire is within 5 milliamperes of the current flowing in the *white (grounded)* all the current will flow in the normal path
- ◆ If the current flow differs by more than 5mA +/- 1mA, the GFCI will quickly open the circuit



## HOW THE GFCI PROTECTS PEOPLE

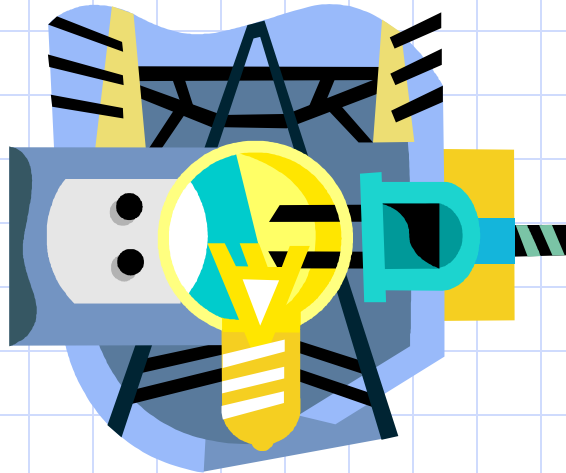
(BY OPENING THE CIRCUIT WHEN CURRENT FLOWS THROUGH A GROUND-FAULT PATH)

# Testing GFCI's

- ◆ GFCI's are complex mechanisms, they must be tested on a regular basis
- ◆ *Installation must be correct according to the listing & labeling requirements or the GFCI will not protect as designed*
- ◆ For permanently mounted types, once a month testing is recommended
- ◆ **Portable GFCI's should be tested before each use!**
- ◆ GFCI's have a test-circuit which imposes an artificial ground fault when the test button is pushed

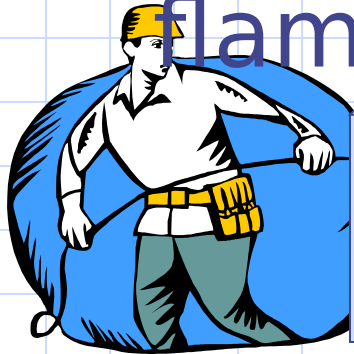
# 1910.305

**Wiring methods,  
components, and  
equipment  
for general use**



# 1910.305(a)(1)(ii) Wiring in ducts

- ❖ No wiring systems of any type shall be installed in ducts used to transport dust, loose stock or flammable vapors



# 1910.305(a)(2) temporary wiring

- ◆ (iii)(F) Lamps for general illumination shall be protected from accidental contact or breakage
- ◆ Protection shall be provided by elevation of at least 7 feet from normal working surface or by a suitable fixture or lampholder with a guard



# 1910.305(a)(2) temporary wiring

- ◆ (iii)(G) Flexible cords and cables shall be protected from accidental damage
- ◆ Sharp corners and projections shall be avoided.
- ◆ Where passing through doorways or other pinch points, flexible cords and cables shall be provided to avoid damage



# 1910.305(a)(2)(iii)(G) Flexible Cords

- ◆ Where passing through doorways or other pinch points, flexible cords and cables shall be provided with protection to avoid damage



# 1910.305 (b) Conductors Entering Boxes, Cabinets or Fittings

- ◆ Conductors can be damaged if they rub against the sharp edges of cabinets, boxes, or fittings
- ◆ Where they enter they must be protected by some type of clamp or rubber grommet
- ◆ The device used must close the hole through which the conductor passes as well as provide protection from abrasion



# 1910.305 (b) Conductors Entering Boxes, Cabinets or Fittings



- ◆ If the conductor is in a conduit and the conduit fits tightly in the opening, additional sealing is not required
- ◆ The knockouts in cabinets, boxes, and fittings should be removed only if conductors are to be run through them
- ◆ Open knockouts and other holes must be closed

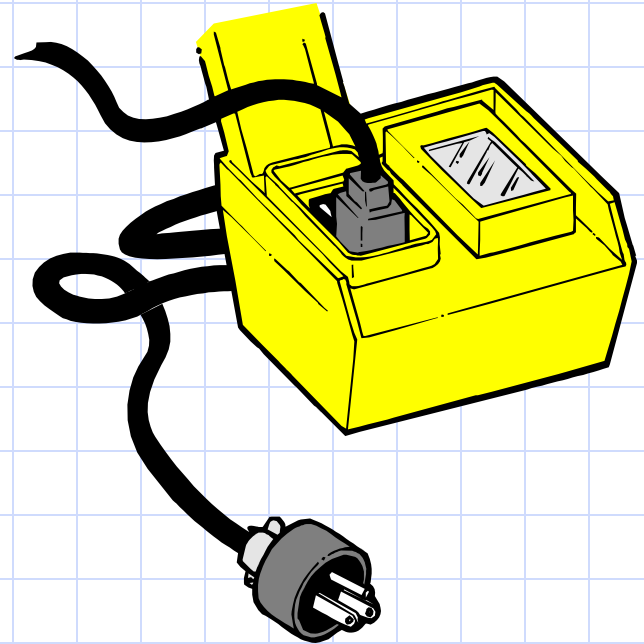
# Conductors Entering Boxes, Cabinets or Fittings

- ◆ All pull boxes, junction boxes and fittings must be provided with approved covers
- ◆ If covers are metal they must be grounded.
- ◆ Each outlet box must have a faceplate or fixture cap



# 1910.305(e) Enclosures for damp or wet locations

- ◆ Cabinets, cutouts boxes, fittings, and panelboards shall be weatherproof
- ◆ Switches, circuit breakers, and switchboards shall be in weather proof enclosures



# 1910.305 (g)(1) Use of Flexible Cords & Cables

- ◆ Flexible cords and shall be approved and suitable for conditions of use and location\*

Underwriters Laboratories  
Inc. (UL)



\* The OSHA electric standard (1910.305) lists specific situations in which flexible cords may be used

# Prohibited uses of flexible cords

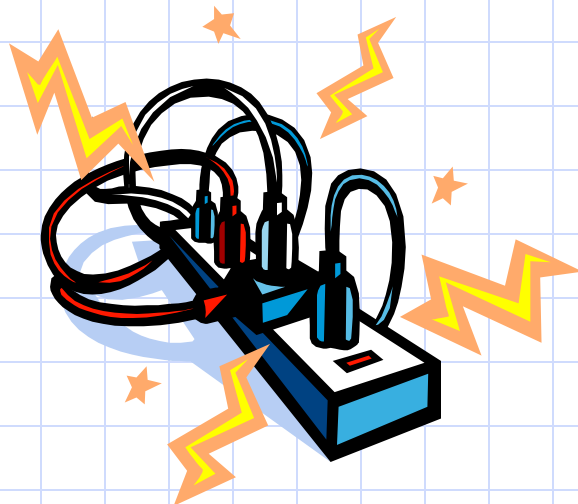
- ◆ Except for the previously listed exemptions, flexible cords ***may not be used for:***
  - (A) As a substitute for fixed wiring of the structure;
  - (B) Where run through holes in walls, ceilings, or floors;



- (C) Where run through doorways, windows, etc..

# Judgment of application

- ◆ There are usually citations when the usage is obviously not temporary; and,
- ◆ When the cord is extended to some distant outlet in order to avoid providing a fixed outlet where needed



# Identification, Splices and Terminations

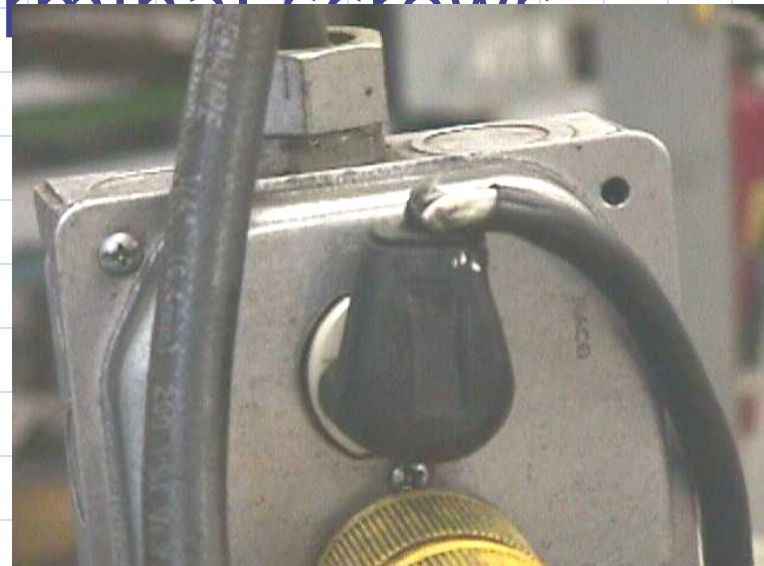
- ◆ Flexible cords shall only be used in continuous lengths, no taps or splices



**Damaged cord  
improperly repaired**

# Identification, Splices and Terminations

- ◆ Flexible cords shall be connected to devices and fittings so that strain relief is provided which will prevent pull from being directly transmitted to joints or terminal screws.

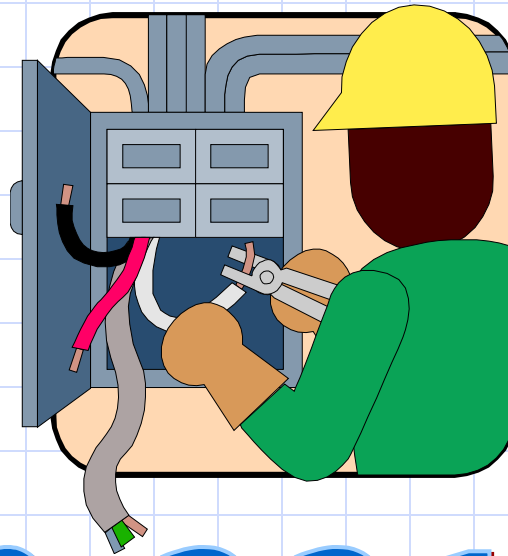


## 1910.305 (g)(2)(ii)

- ◆ Flexible cords shall be used only in continuous lengths without splice or tap.
- ◆ Hard service flexible cords No. 12 or larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.

Note: The National Electric Code allows splice in 14 gauge or greater wire

# Safety-Related Work Practices



1910.331-335

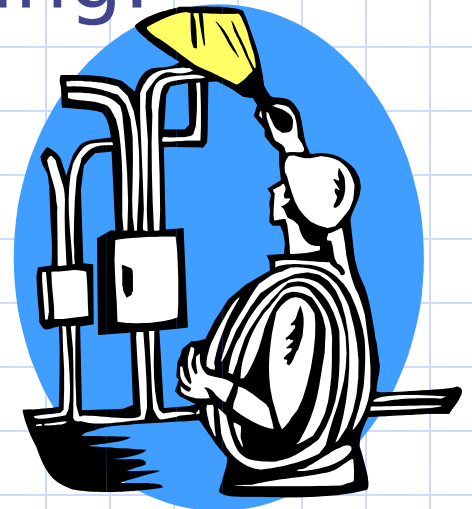
# 1910.331 Scope

## ◆ Covers:

- Qualified persons (those who have training in avoiding the electrical hazards)
- Unqualified persons (those with little or no such training)

## ◆ Working on or near the following:

- Premises wiring
- Wiring for connection to supply
- Other wiring



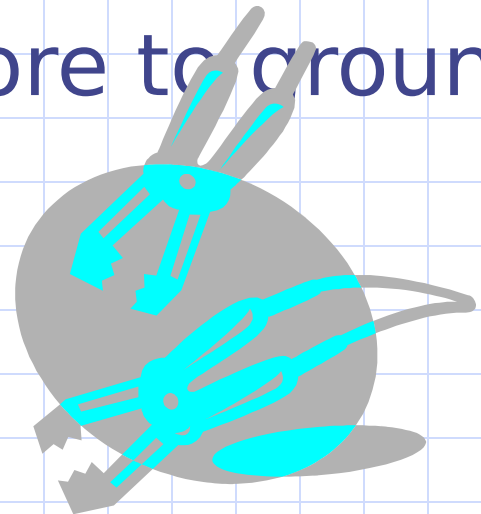
# 1910.332 Training

## ◆ Scope:

- The training requirements contained in this section apply to employees who face a risk of electric shock that is not reduced to a safe level by the electrical installation requirements of 1910.303 through 1910.308
- Employees shall be trained in and familiar with the safety-related work practices required by 1910.331 through 1910.335 that pertain to their respective job assignments

# Footnote to Table S-4

- ◆ (1) Workers in these groups do not need to be trained if their work or the work of those they supervise does not bring them or their employees close enough to exposed parts of electric circuits operating at 50 volts or more to ground for a hazard to exist.



# 1910.332 Training

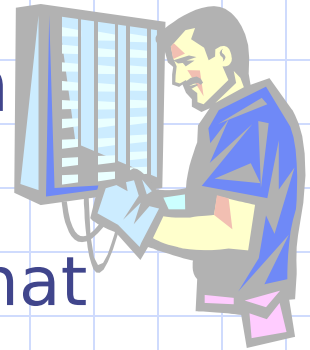
- ◆ (b)(3) Qualified persons: (i.e. those permitted to work on or near exposed energized parts) shall, at a minimum, be trained in and familiar with the following:
  - (i) The skills and techniques necessary to **distinguish exposed live parts** from other parts of electric equipment
  - (ii) The skills and techniques necessary to **determine the nominal voltage** of exposed live parts
  - (iii) The **clearance distances** specified in 1910.333(c)

# 1910.333 (a)(1)

## Deenergized parts

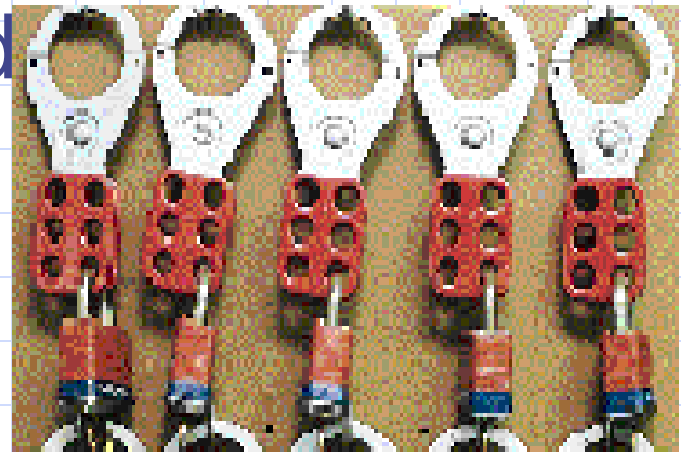
◆ Live parts to which an employee may be exposed shall be deenergized before the employee works on or near them:

- Unless the employer can demonstrate that deenergizing introduces additional or increased hazards or is infeasible
- Live parts that operate at less than 50 volts to ground need not be deenergized if there will be no increased exposure to electrical burns or to explosion due to electric arcs



# 1910.333(b) Working on or near exposed deenergized parts

- ❖ (1) Conductors and parts of electric equipment that have been deenergized but have not been locked out or tagged in accordance with paragraph (b) of this section shall be treated as energized parts



## 1910.333(c)(4) Illumination

- ◆ Employees may not enter spaces containing exposed energized parts, unless illumination is provided that enables the employees to perform the work safely



# 1910.333(c)(4) Illumination



- ◆ Employees may not reach blindly into areas which may contain energized parts.

# 1910.333(c)(7) Portable ladders

- ◆ Portable ladders shall have nonconductive siderails if they are used where the employee or the ladder could contact exposed energized parts



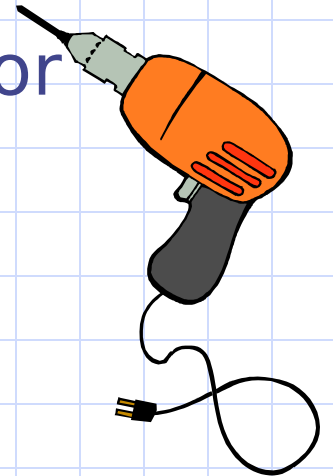
# 1910.333(c)(8) Conductive apparel

- ◆ Conductive articles of jewelry and clothing (such a watch bands, bracelets, rings, key chains, necklaces, etc...) may not be worn if they might contact exposed energized parts



# 1910.334 Use of equipment

- ◆ Portable equipment shall be handled in a manner which will not cause damage
- ◆ Flexible electric cords connected to equipment may not be used for raising or lowering the equipment
- ◆ Flexible cords may not be fastened with staples or otherwise hung in such a fashion as could damage the outer jacket or insulation



# 1910.334 (a)(2)(i) Use of equipment

- ◆ Portable cord and plug connected equipment and flexible cord sets (extension cords) **visually inspected before use for external defects** (such as loose parts, or damage to outer jacket or insulation) and for evidence of possible internal damage (pinched or crushed outer jacket)
- ◆ Extension cords which remain connected once they are put in place and are not exposed to damage need not be visually inspected until they are relocated

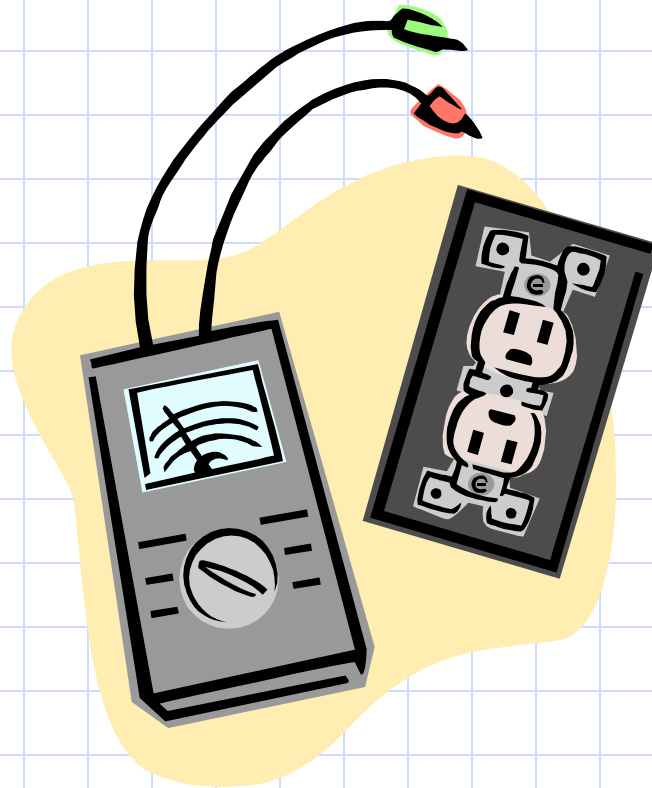
# 1910.334 Use of equipment

- ◆ A flexible cord used with grounding type equipment shall contain an equipment grounding conductor
- ◆ Attachment plugs and receptacles may not be connected or altered in a manner which would prevent proper continuity of the equipment grounding conductor at where plugs are attached to



# 1910.334 (c)(1) Use

- ◆ Only **qualified persons** may perform testing work on electric circuits or equipment



# 1910.334 Use of equipment

- ◆ (c)(2) "Visual inspection." Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before the equipment is used.
- ◆ If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made.

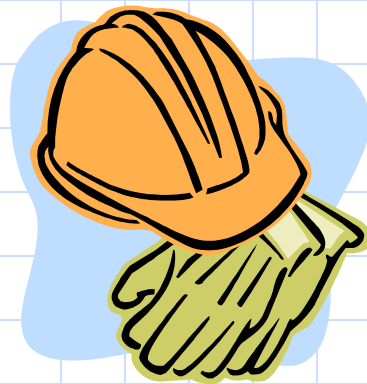
# 1910.335 Safeguards for personnel protection

- ◆ (a)(1) Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work performed



# 1910.335 Safeguards for personnel protection

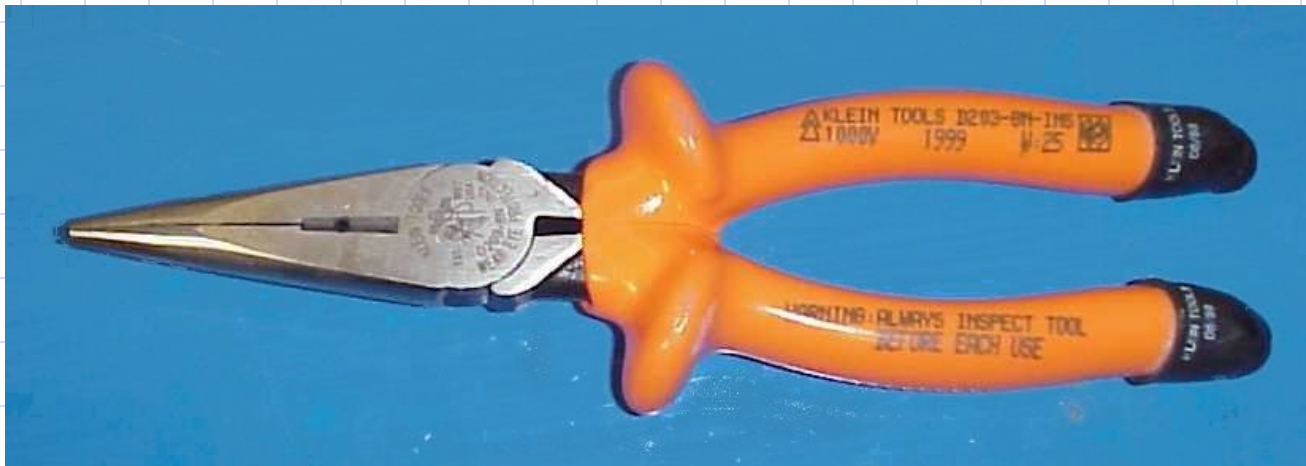
- ◆ (a)(1)(ii) Protective equipment shall be maintained in a safe, reliable condition and shall be periodically inspected or tested, as required by 1910.137 \*



**\*1910.137 Electrical protective equipment**

# 1910.335 Safeguards for personnel protection

- ◆ (a)(2)(i) When working near exposed energized conductors or circuit parts, each employee shall use insulated tools or handling equipment if the tools or handling equipment might make contact with such conductors or parts



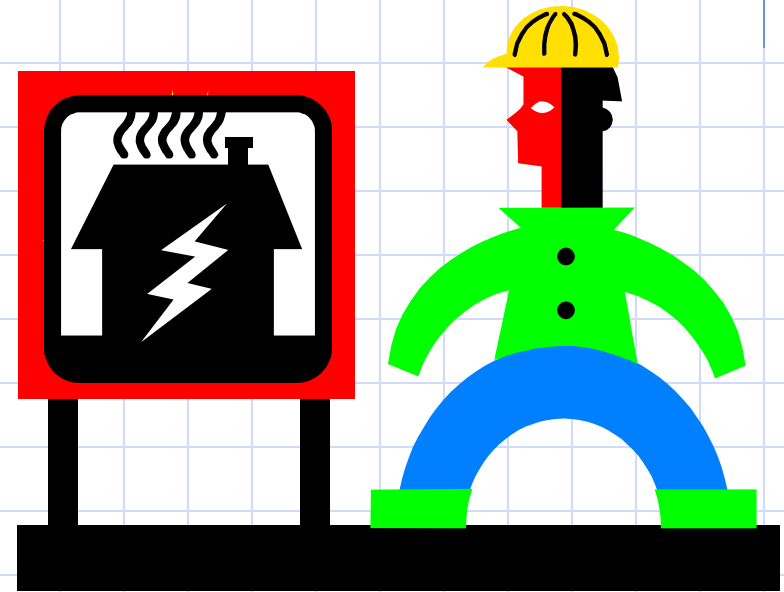
# 1910.335 Safeguards for personnel protection

◆(b)The following alerting techniques shall be used to warn and protect employees from hazards which could cause injury due to electric shock, burns, or failure of electric equipment parts:

- Safety signs and tags
- Barricades
- Attendants

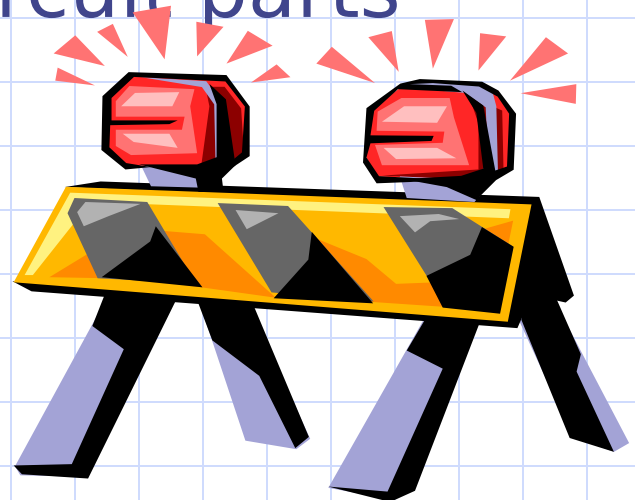
# 1910.335 Safeguards for personnel protection

◆(b)(1) Safety signs, safety symbols, or accident prevention tags shall be used where necessary to warn employees about electrical hazards which may endanger them, as required by 1910.145



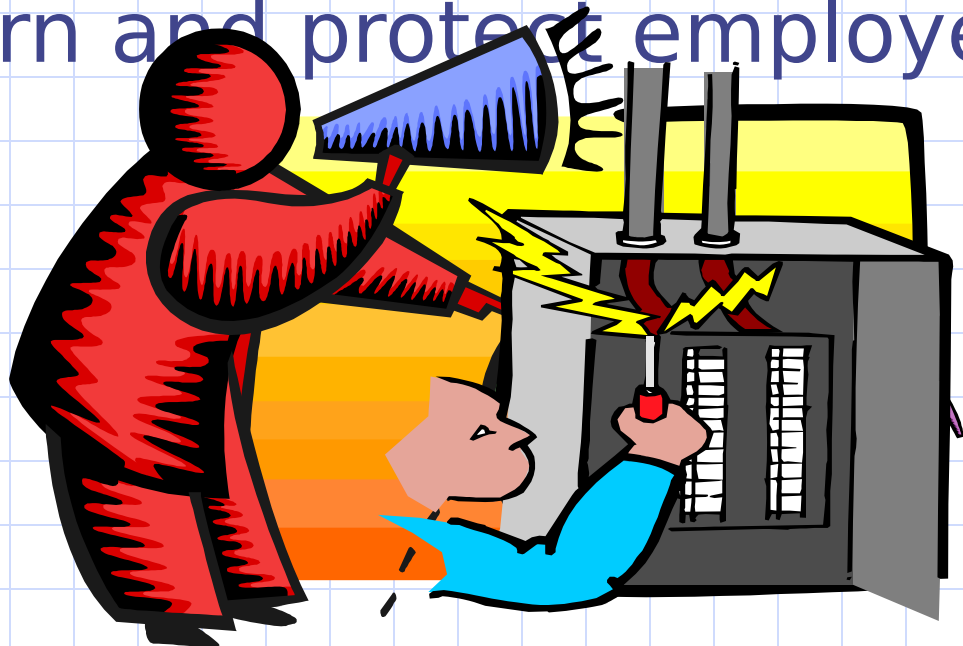
# 1910.335 Safeguards for personnel protection

- ◆ (b)(2) Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas exposing employees to uninsulated energized conductors or circuit parts

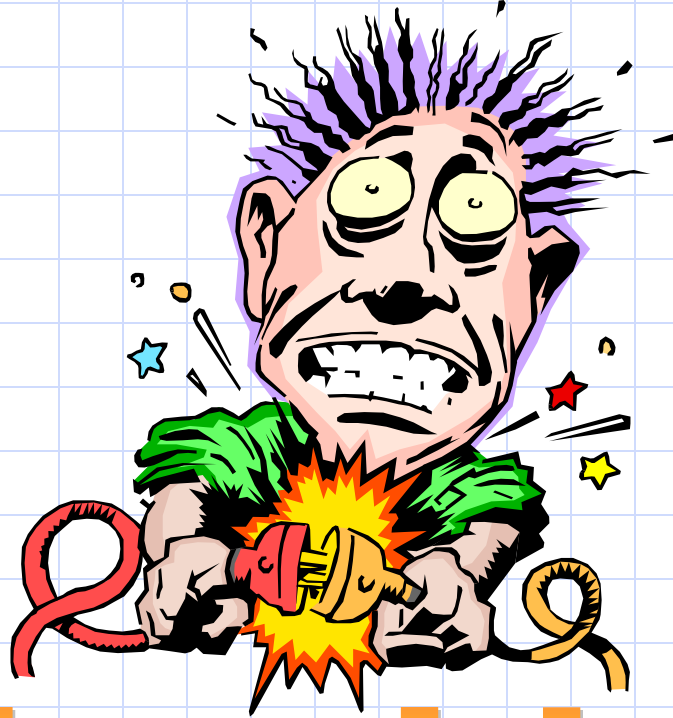


# 1910.335 Safeguards for personnel protection

◆ If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees



**Work  
Shouldn't be...**



**Shocking!**